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The work sponsored under this award resulted in the discovery of several important physical phenomena and the nucleating ideas behind three new technologies. Of particular importance was the discovery of laser action in strongly scattering media, a material now known as LaserPaint. This discovery has created a new field in optics which has an impact on light localization physics and many optical devices. The use of the technology in photodynamic therapy was awarded a Rolex Award in 1996.

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**Final Report
AFOSR Grant No. F49620-94-1-0013**

**Novel Composite Materials for Nonlinear
Optics and Information Storage**

by

Principal Investigator:
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April 15, 1997

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Summary of Accomplishments for the Grant Period 12/1/93 - 11/30/96

The work sponsored under this award resulted in the discovery of several important physical phenomena and the nucleating ideas behind three new technologies. Of particular importance was the discovery of laser action in strongly scattering media, a material now known as LaserPaint. This discovery has created a new field in optics which has an impact on light localization physics and many optical devices. The use of the technology in photodynamic therapy was awarded a Rolex Award in 1996.

In addition to this important discovery, the group showed how trapped photoexcited carriers in glasses could produce selective etching. This work led to the elucidation of the charge pattern responsible for glass SHG using atomic force microscopy. Use of the technique also resulted in the determination of the role of centers in this process. The method was also extended to produce binary optical elements using direct laser writing and complemented a third technology we developed which uses semiconductor doped glasses to directly fabricate surface features in glass.

In total, the group produced 36 publications, 24 conference presentations, and three patents based on this work. In addition, the grant support has made possible the research of four new Ph.D.'s over the past three years.

Publications (1994 - 1996)

1. Driscoll, T. J., and Lawandy, N. M., "Optically Encoded Second-Harmonic Generation in Bulk Silica-Based Glasses," *JOSA B* **11(2)**, 355 (1994).
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13. Lawandy, N. M. and Balachandran, R. M., "Random Laser?," *Nature* **373**(6511), 203 (1995).
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15. Beadie, G., Sauvain, E., Gomes, A. S. L., and Lawandy, N. M., "Temperature Dependence of Carrier Relaxation in Semiconductor Doped Glasses," *Physical Review B* **51**(4), 2180 (1995).
16. Li, Shaozhong, Khurgin, Jacob B., and Lawandy, N. M., "Optically-Induced Anderson Delocalization Transition in Disordered Systems," *Optics Communications* **115**, 466 (1995).
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2. Vartak, S., and Lawandy, N. M., "Electron Acceleration by Optical Rectification: Breaking the Attosecond Barrier," Paper No. QThC4, International Quantum Electronics Conference, Anaheim, CA, May 8-13, 1994.
3. Balachandran, R. M., and Lawandy, N. M., "Laser Action in Strongly Scattering Media," Paper No. QFE1, International Quantum Electronics Conference, Anaheim, CA, May 8-13, 1994.
4. Vartak, Sameer, and Lawandy, N. M., "Generation of Attosecond Electron Pulses Using Optical Rectification," Paper No. QTuL4, International Quantum Electronics Conference, Anaheim, CA, May 8-13, 1994.
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7. Kyung, Jae H., Sauvain, E., and Lawandy, N. M., "Micron-Scale Maskless Photoetching in Transparent Borosilicate Glasses," Paper No. MP2, Optical Society of America Annual Meeting, Dallas, TX, October 2-7, 1994.
8. Balachandran, R. M., and Lawandy, N. M., "Spatio-Temporal Studies in Strongly-Scattering Gain Media," Paper No. TuN1, Optical Society of America Annual Meeting, Dallas, TX, October 2-7, 1994.
9. Vartak, S. D., and Lawandy, N. M., "Enhancement of Spontaneous Decay Rates by Plasmon Increased Vacuum Field Coupling," Paper No. Th14, Optical Society of America Annual Meeting, Dallas, TX, October 2-7, 1994.
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19. Kyung, Jae H., and Lawandy, N. M., "Measurement of Photo-Induced Charge Distribution in Seeded Second Harmonic Generation by Charge-Selective Etching in Glasses," OSA Topical Meeting: Photosensitivity and Quadratic Nonlinearity in Glass Waveguides '95, Portland, OR, September 9-11, 1995.
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21. Lawandy, Nabil M., and Driscoll, Timothy J., "Laser Action in Scattering Gain Media for Lasing Pixel Applications," Society for Imaging Science and Technology (IS&T) 49th Annual Conference, Minneapolis, MN, May 19-24, 1996.
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Ph.D. Students and Undergraduate Research

Gyeong-il Kweon	Molecular Interactions in Electromagnetically Structured Systems (1994)
Guy M. Beadie	Picosecond Measurements of Photogenerated Carrier Transport at Semiconductor Nanocrystal-Glass Interfaces and Microlens Fabrication in Semiconductor Doped Glasses (1995)
Rammohan Balachandran	Laser Action in Scattering Gain Media (1996)
Jae H. Kyung	Microscopic Processes for Second Harmonic Generation and Applications of Selective Etching Effect in Photo-Encoded Glasses (1996)